# Process control for silicon-germanium

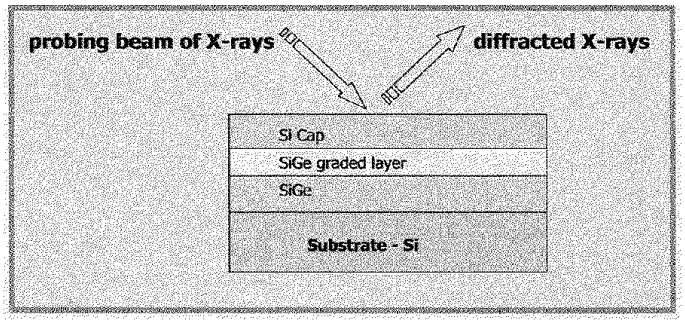
**Philips Analytical** (Almelo, The Netherlands) has launched its DCD Pro X-ray Diffraction Analyzer for ultra-fast rocking curve wafer mapping. This provides an accurate measure of lattice parameter (*d*) and film thickness (of epi-layers just a few atoms thick). It can be used not only for process development but even for high-volume production control (which has so far been limited by a lack of suitable test equipment and skilled staff).

As well as analysing III-V, II-VI, GaN and HEMT devices, the DCD Pro gives an absolute measure of the SiGe grading profile in the base region of SiGe HBTs. The wafers in a 25-wafer cassette can be measured and analysed well within 1 hour, with automated handling and data analysis (cassette-to-cassette tools aid integration into the fab line), and can measure epi-layers thinner than 20 nm in less than a minute.

Wafers that fail to meet specifications can be removed from post-epi production steps. Alternatively, the analyzer can detect defects with greater detail and more accuracy by conducting more rocking-curve analyses per wafer.

The DCD Pro uses a 2.2 kW source to direct a high-intensity, highly collimated x-ray beam on to a sample wafer (up to 200mm). The x-ray source also enables the analysis of complex, weakly diffracting multi-layer structures. Dynamic range is more than five orders of magnitude, enabling accurate measurement of both strong substrate peaks and weak peaks from very thin layers.

The tools can perform all the diffraction and reflectivity measurements of Bede's research diffractometers (i.e. high-resolution XRD, thin-film reflectivity; texture measurements; stress measurements; triple-axis diffraction and reciprocal space maps; powder/polycrystalline film XRD; diffuse scatter). But higher speed and full automation enable use in both high-volume fabrication lines and advanced characterisation labs (using large wafers for characterising new pre-production processes such as SiGe epitaxy).




*Pictured: Cross-sectional schematic diagram showing x-ray diffraction metrology of a typical SiGe HBT device structure (courtesy of Bede plc).*

**Bede plc** (Durham, UK) has introduced two new x-ray tools for large wafers:
- the Fab200 (which has a SMIF front-end for handling both 200 mm silicon wafers and 50-150 mm wafers in compound semiconductor foundries); and
- the Fab300 (which has a Class 1 minienvironment and FOUP loadport for 300 mm silicon wafers).

Germanium composition and layer thicknesses are now routinely available to a repeatability of 0.5 % of value on box layers in a non-contacting, non-destructive and completely automated tool.

# Low-temp pre-clean for SiGe epi

Applied Materials Inc (Santa Clara, CA, USA) has introduced the EpiClean pre-clean chamber (fully integrated on its Epi Centura system) for high-throughput SiGe, SiGe:C and Selective Epitaxial Growth (SEG) low-temperature epitaxial deposition.

*"We anticipate the market for SiGe-based ICs to grow more than 20% per year for the next several years as these devices move from development into production"*, says Grant Imper, general manager of the Epi Substrate Division.

Many new communications ICs are highly sensitive to elevated temperatures during fabrication and require reductions from the traditional 1000-1200°C range down to 600-800°C. The EpiClean chamber performs a pre-deposition clean process, removing native oxide layers and other contaminants at temperatures below 780°C.

By using a low-temperature, low-pressure hydrogen bake process outside the deposition chamber, the EpiClean process eliminates the need for a high-temperature bake or stabilisation step in the deposition chamber, greatly reducing process time, increasing throughput and lowering operating cost.

Compared to HF-type preclean chambers, the EpiClean chamber also provides significantly lower oxygen and carbon levels at the wafer surface.

•Applied claims the world's largest installed base of SiGe and SEG epi deposition chambers.

## Equipments & Materials Processing

As part of a unification of an international operation under its parent company Japan Energy Corp, NIMTEC Inc has changed its name to Nikko Materials (Tel: +1-978-777-9655). Japan Energy Corp subsidiaries NIMTEC GmbH in Europe, Japan Energy Pte Ltd in Singapore, and Japan Energy (Taiwan) Co have also been unified under the Nikko Materials name. As well as producing sputtering targets, Nikko Materials offers InP and GaAs wafers.

Nitride substrate supplier Kyma Technologies (Research Triangle Park, NC, USA) has been joined by 20-year veteran of the compound industry Larry Kaplan as vice president. Kaplan will provide expertise in R&D, engineering, product development and manufacturing, and drive the transition of Kyma's line of nitride substrate products from the engineering phase to pilot production.

Kaplan was previously instrumental in creating, building and managing RF Micro Devices' HBT facilities and has held executive and management positions at Alpha Industries and UED.

The US Army Research Laboratory (ARL) is now licensing use the GaN-related US Patent 6,177,688 *"Low Defect Density Gallium Nitride Epilayer and Method of Preparing the Same"* issued in January. "A GaN epilayer grown on a lattice mismatched sapphire substrate is subjected to rapid thermal processing in order the reduce the defect density especially in the proximate the top (device) surface of the GaN epilayer." For information contact: *ARL Technology Transfer Office, Aberdeen Proving Ground, Maryland (Tel: +1-410-278-5028)*